



NASA Glenn Research Center

75 Years of Innovation

James M. Free
Director, Glenn Research Center
Cleveland, Ohio



Who Is NASA Glenn Today?



Lewis Field (Cleveland)

- 350 acres
- 1626 civil servants and 1511 contractors
- 66% of workforce are scientists and engineers



Plum Brook Station (Sandusky)

- 6500 acres
- 11 civil servants and 102 contractors



NASA Glenn Awards and Recognition



R&D 100 Awards (1966 to 2014)—Glenn has 118, highest in the Agency in these disciplines

- Aeropropulsion systems
- Aerospace communications
- In-space propulsion systems
- Power and energy conversion



Colliers

- Contributions to airline accident reduction (2008)
- Advance turboprop technology (1987)
- Thermal ice prevention systems (1946)



Emmy

- Contributions to the Communications Technology Satellite (1987)



Patents

- 43 to Glenn
- 38 to Glenn partners (fiscal years 2010 to 2013) as of July 25, 2013



NASA Software of the Year

- 5 Glenn awards in the past 15 years



FLCs

- Federal Laboratory Consortium (FLC) Excellence in Technology Transfer (2009 and 2011)



Presidential Rank (2005 to 2011)

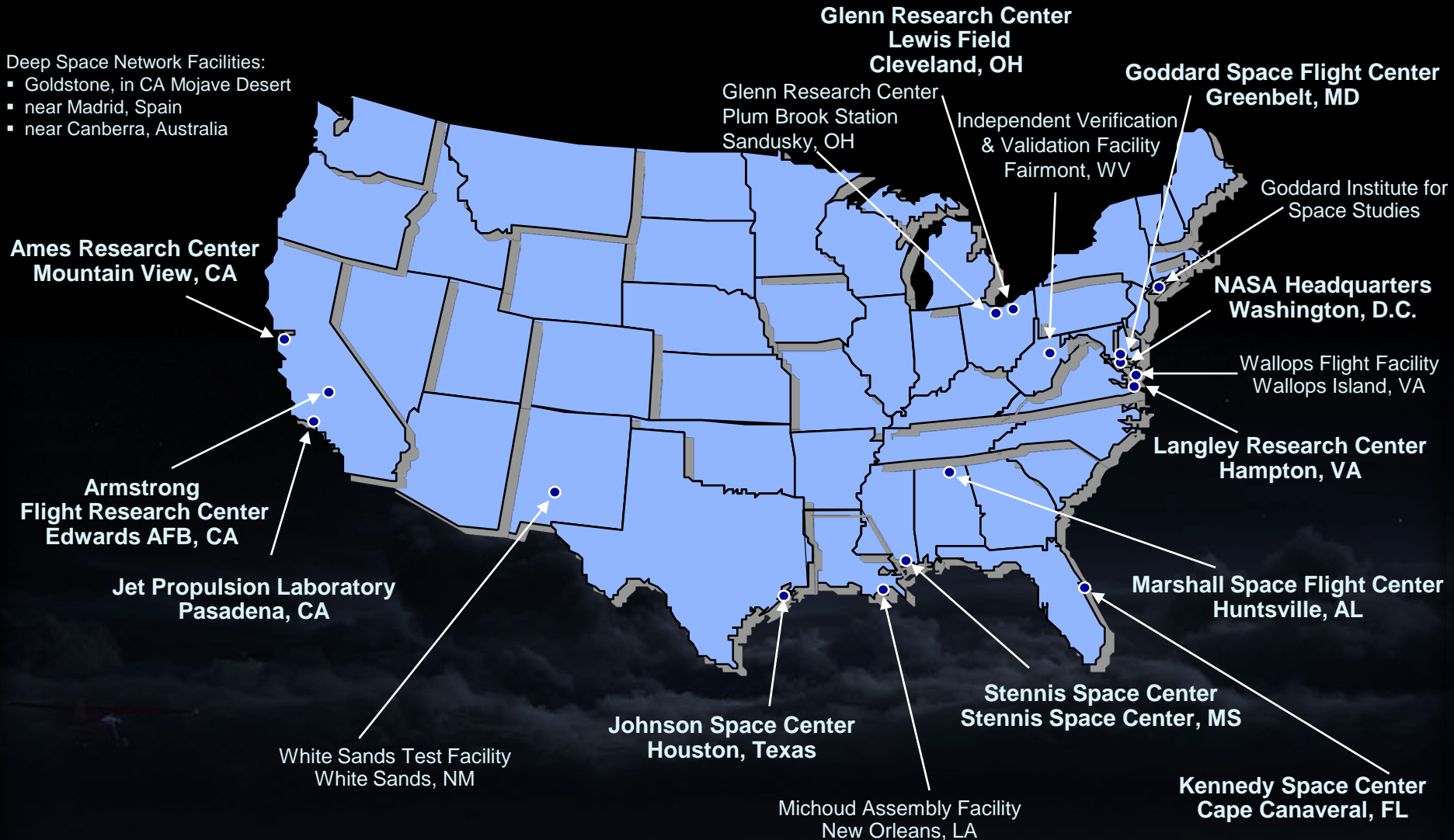
- 17 Meritorious
- 4 Distinguished



NASA Centers and Installations

Deep Space Network Facilities:

- Goldstone, in CA Mojave Desert
- near Madrid, Spain
- near Canberra, Australia





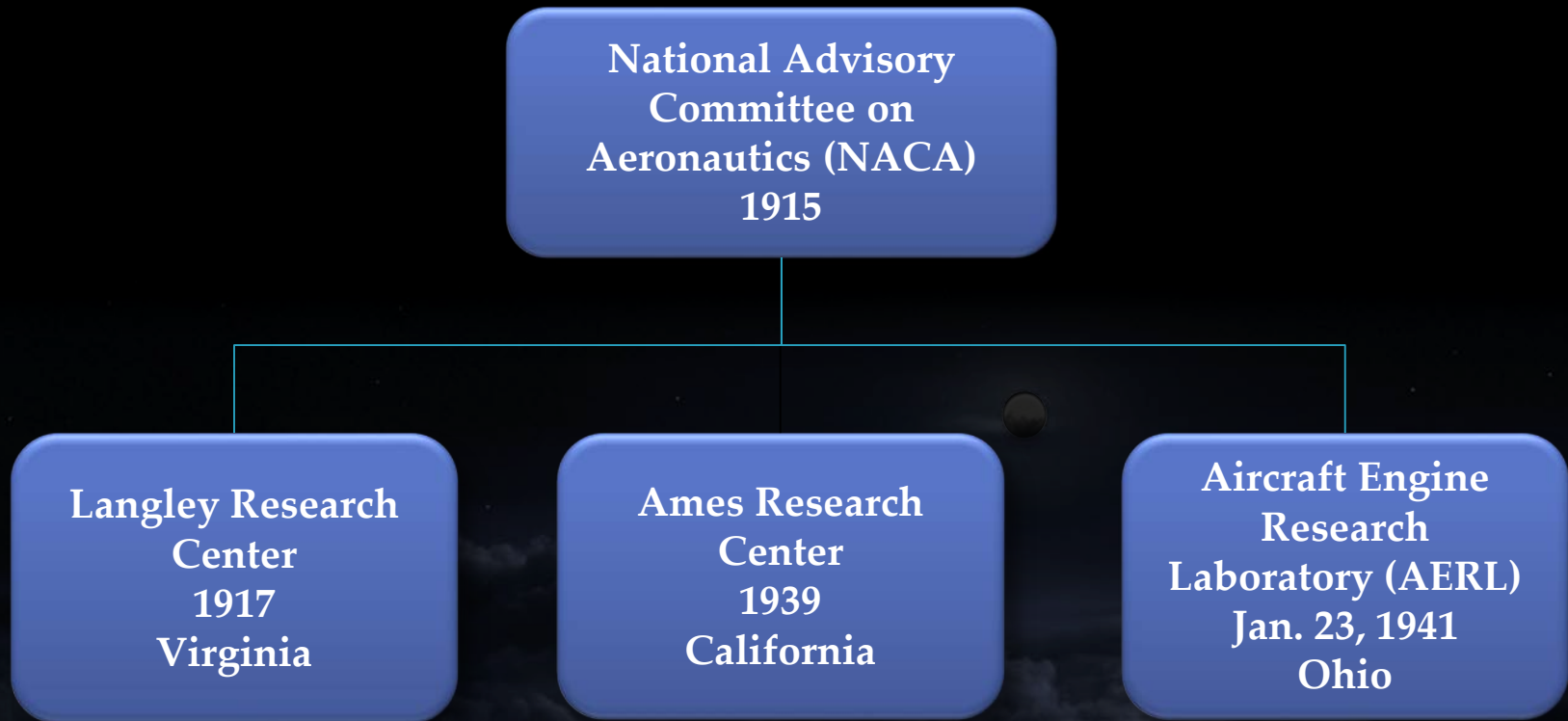
A century ago...

*...it shall be the duty of the Advisory
Committee for Aeronautics to supervise and
direct the scientific study of the problems of
flight with a view to their practical
solution...*

Act of Congress, approved March 3, 1915

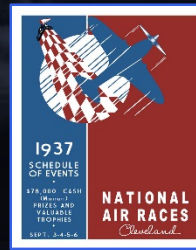
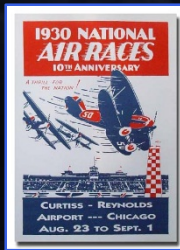
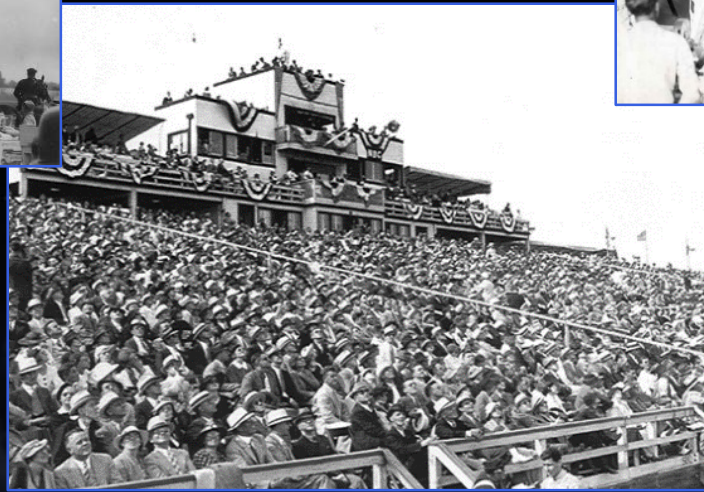
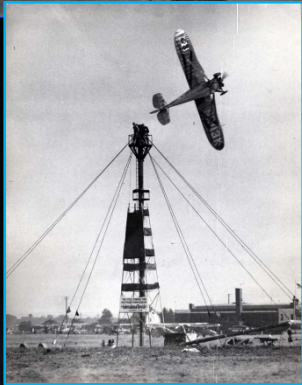


Birth of U.S. Aeronautics Research



THE NACA RESEARCH FACILITIES

The Roots of NASA Glenn



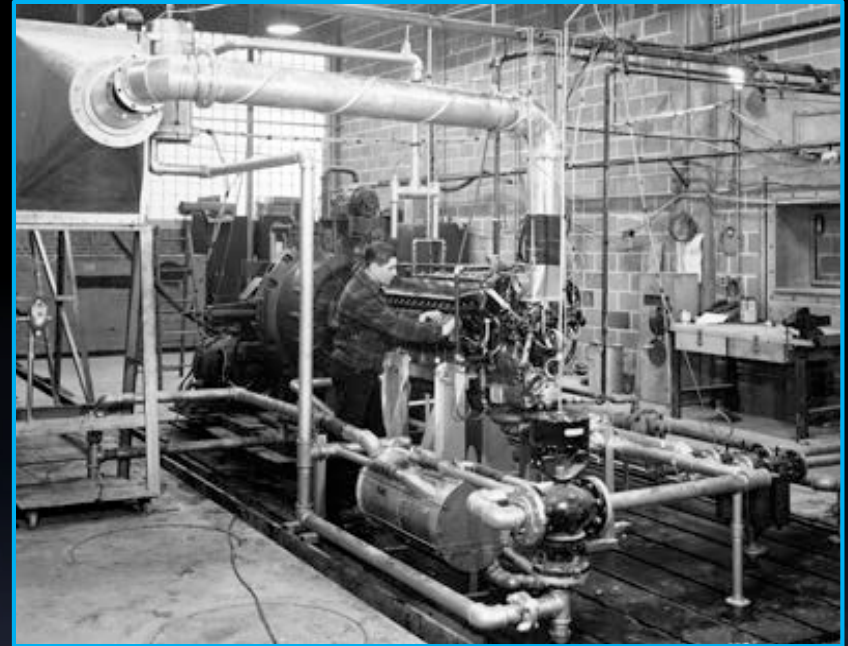
The Roots of NASA Glenn



The Roots of NASA Glenn



NASA Glenn Goes to War



AERL OPEN FOR THE BUSINESS



NASA Glenn Goes to War



**1942: INITIATION OF RESEARCH CEREMONY
ENGINE PROPELLER RESEARCH BUILDING**

NASA Glenn Goes to War



AERL IS OFFICIALLY DEDICATED

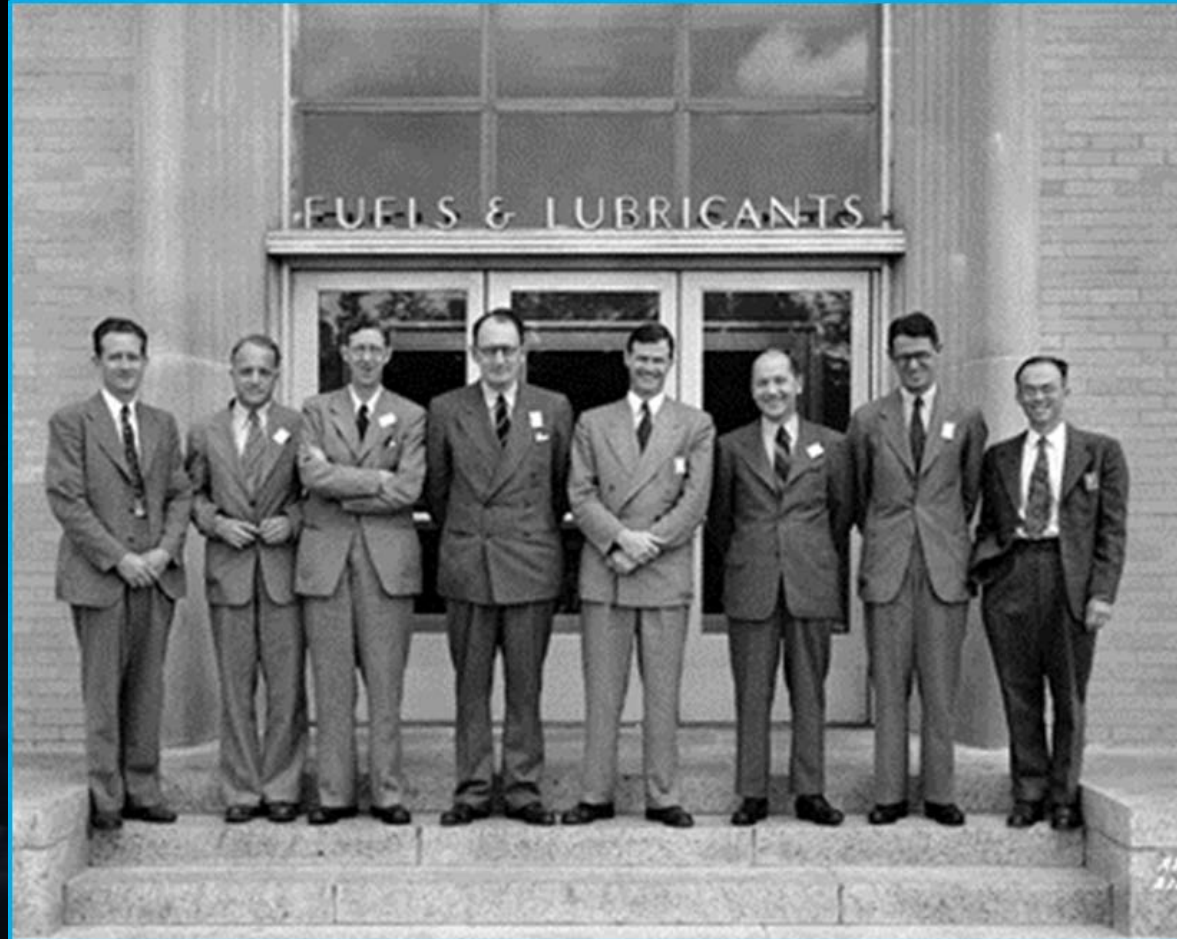
NASA Glenn Goes to War



IN-FLIGHT AERONAUTICS RESEARCH



NASA Glenn Goes to War



THE AERL WELCOMES VISITORS



NASA Glenn Goes to War



ALTITUDE WIND TUNNEL, ONE OF A KIND



NASA Glenn Goes to War



ALTITUDE WIND TUNNEL, FIRST PROJECT



NASA Glenn Goes to War

FLYING LABORATORY



THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS
ESTABLISHED BY THE U. S. GOVERNMENT IN 1915, IS
OFFERING EMPLOYMENT TO MEN AND WOMEN COLLEGE
STUDENTS IN ALL FIELDS OF ENGINEERING, MATHEMATICS
AND PHYSICS WHO WILL GRADUATE WITHIN THE NEXT 8 MONTHS

It offers

A Career in Aeronautical Research
Permanent Activity
Freedom from Monotony

YOU ARE INVITED TO ARRANGE WITH YOUR PLACEMENT DIRECTOR
FOR A PERSONAL INTERVIEW WITH OUR REPRESENTATIVE ON
1944, AT ____ M. IN ____

AMES AERONAUTICAL
LABORATORY
MOFFETT FIELD, CAL.

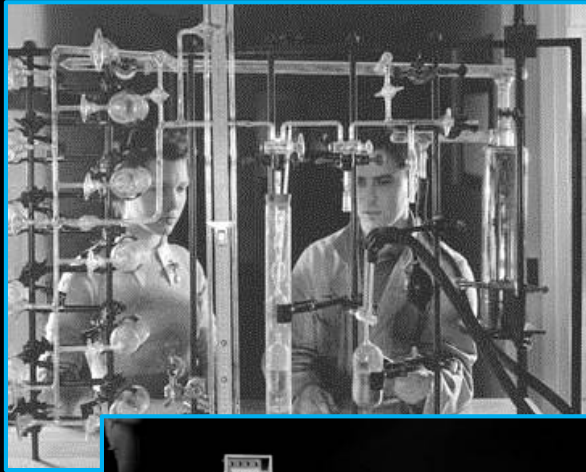
LANGLEY MEMORIAL
AERONAUTICAL LABORATORY
HAMPTON, VA.

AIRCRAFT ENGINE
RESEARCH LABORATORY
CLEVELAND, O.

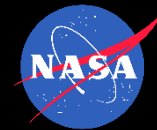
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RESEARCH EMPLOYMENT OPPORTUNITIES

NASA Glenn Goes to War



TACKLING WARTIME RESEARCH IN MANY AREAS

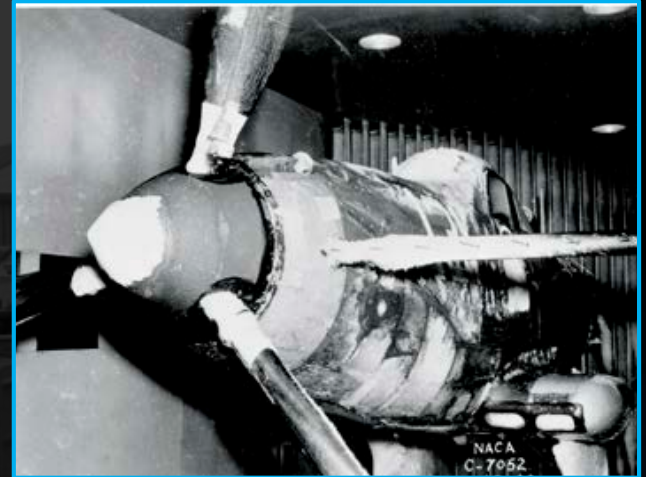


NASA Glenn Goes to War



B-29 IN-FLIGHT & GROUND RESEARCH

NASA Glenn Goes to War



ICING RESEARCH TUNNEL



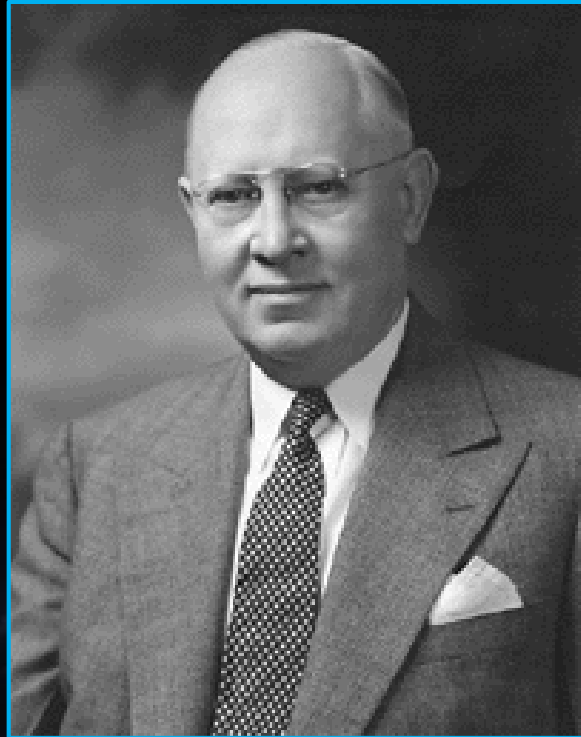
NASA Glenn: a New Direction



NACA AERL 1945



NASA Glenn: A New Direction

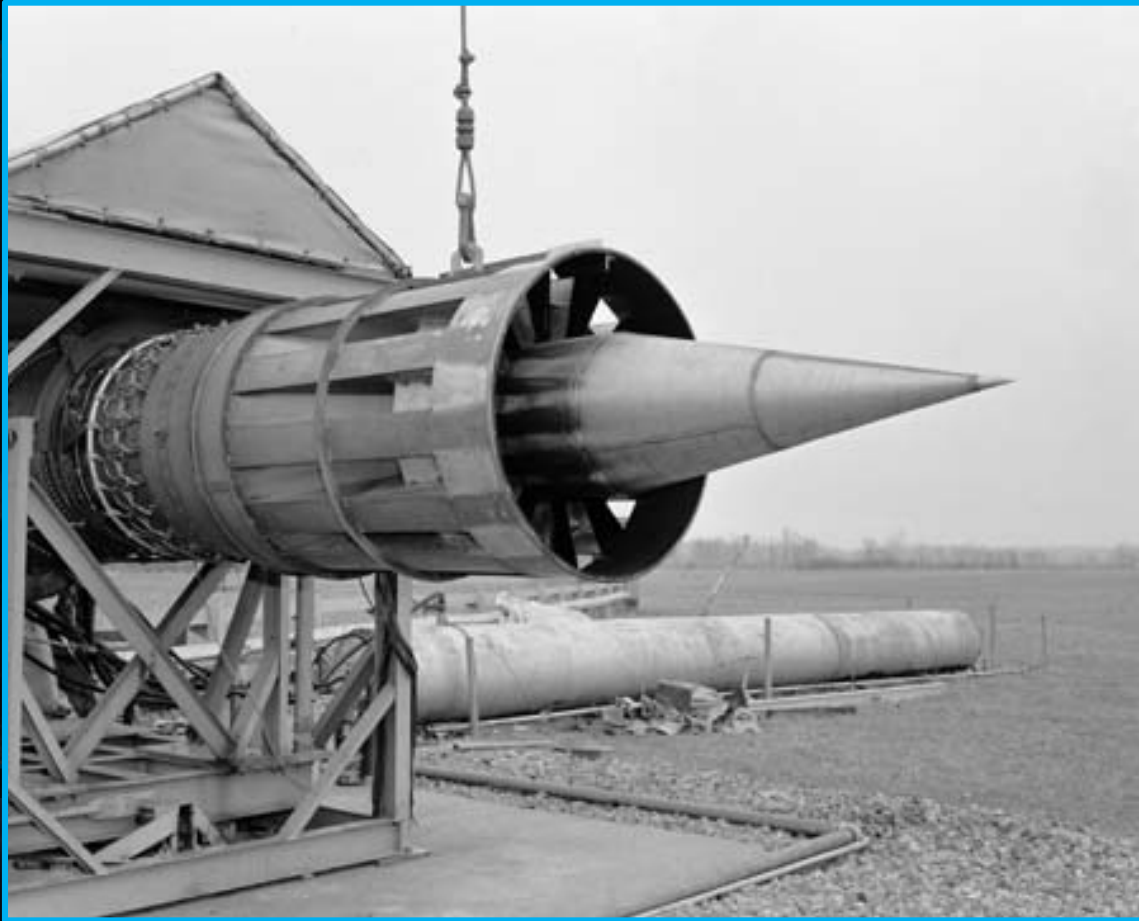


George W. Lewis
NACA Director of Aeronautical Research
1924 - 1947

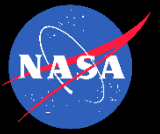
LEWIS FLIGHT PROPULSION LABORATORY



NASA Glenn: Enters The Jet Age



LEWIS FLIGHT PROPULSION LABORATORY



NASA Glenn: Furthering Aircraft Safety



LEWIS FLIGHT PROPULSION LABORATORY



NASA Glenn: Preparing For Space



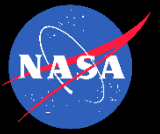
LEWIS RESEARCH CENTER ROCKET ENGINE TEST FACILITY



NASA Glenn: On The Path to Space



LEWIS RESEARCH CENTER MULTIPLE-AXIS SPACE TEST INERTIA FACILITY



NASA Glenn: On The Path to Space



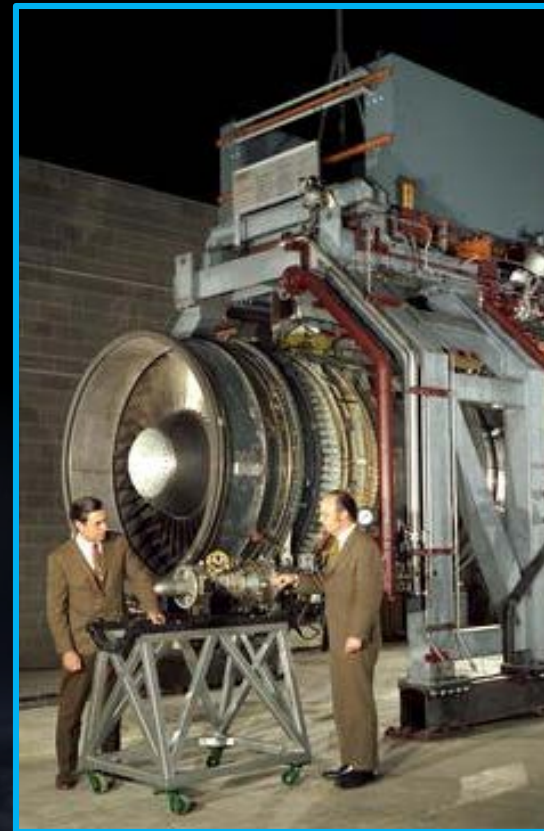
**LEWIS RESEARCH CENTER
MERCURY TO CENTAUR**



NASA Glenn: Transitions



NASA Glenn: Transitions



LEWIS RESEARCH CENTER AND PLUM BROOK STATION

NASA Glenn: Reordering Priorities



LEWIS RESEARCH CENTER SPACE SHUTTLE TO TURBO PROP TO ICING



NASA Glenn: Going Green

Technology Readiness Level (TRL) Process

NASA's quest to make jet engines quieter led to the development of chevrons, which moved relatively quickly through the TRL process to be deployed into the commercial marketplace.



TRL 8-9 (2005-now)

- Certification by the Federal Aviation Administration
- Deployed into market



TRL 7 (2001-2005)

- Validation of concept in flight
- Flight tests, final design



TRL 6 (1998-2000)

- Full scale tests for acoustics and aerodynamics
- Static engine tests

TRL 4-5 (1995-1997)

- Model tests for acoustics and aerodynamics
- Sub-scale model tests



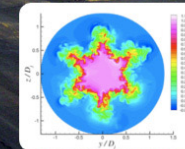
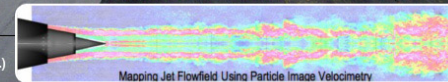
TRL 3 (Early 1990s)

- Applications to small nozzles and airfoils
- Lab tests, concept on paper



TRL 1-2 (1980s)

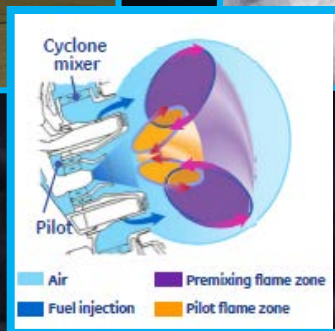
- Fundamental investigations of air-mixing devices (tabs, chevrons, etc.)
- No specific application, basic research in fluid physics



LEWIS RESEARCH CENTER CHEVRON NOZZLES—FROM IDEA TO DEPLOYMENT



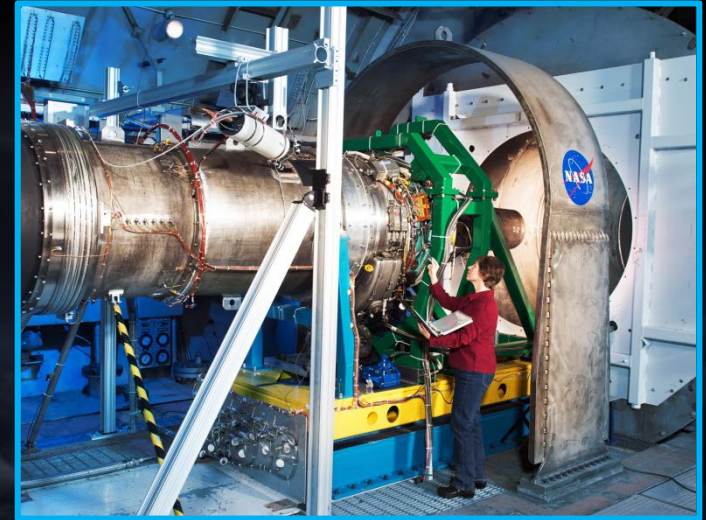
NASA Glenn: Going Green



GLENN RESEARCH CENTER TAPS—FROM IDEA TO DEPLOYMENT



NASA Glenn: Advancing Aeronautics

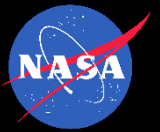


GLENN RESEARCH CENTER SUPERSONICS, BIOFUELS, ICING AND UAS

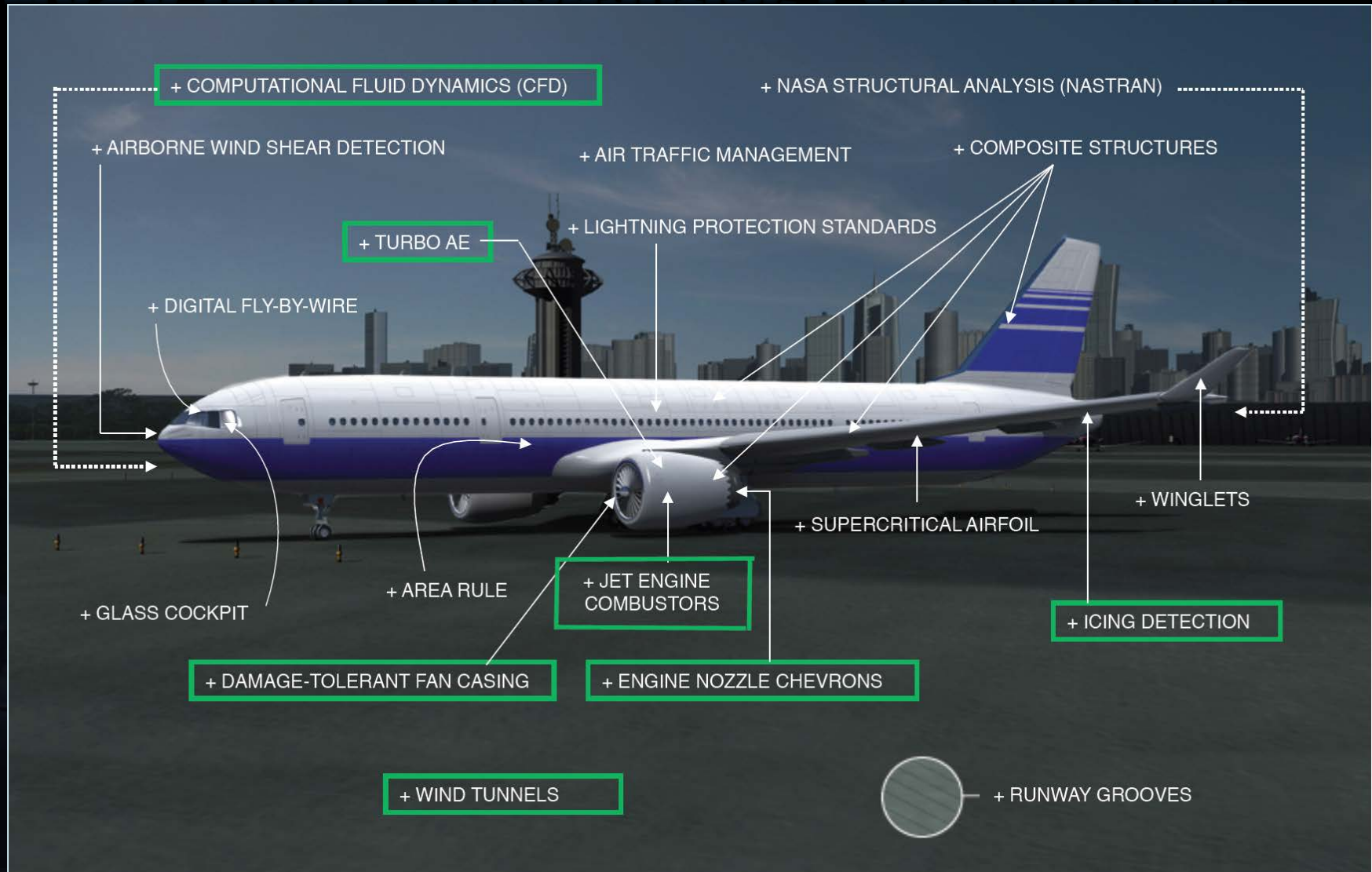


NASA Glenn: Looking to The Future





NASA Glenn Aeronautics Contributions



NASA Glenn: Unique Aero Facilities



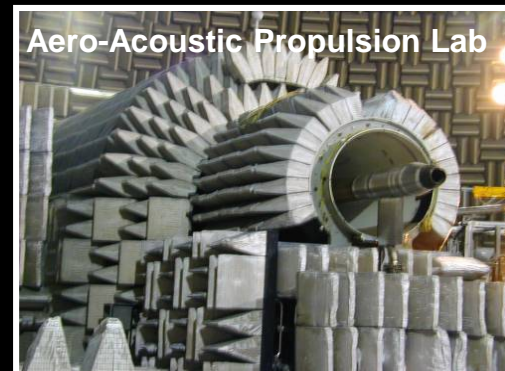
Subsonic Propulsion Wind Tunnels

- Noise suppression
- Inlet/Airframe integration
- STOVL hot gas ingestion



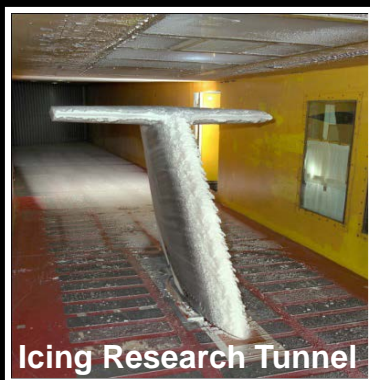
Transonic and Supersonic Propulsion Wind Tunnels

- Advanced propulsion concepts
- Inlet/Airframe Integration
- Internal/external aerodynamics



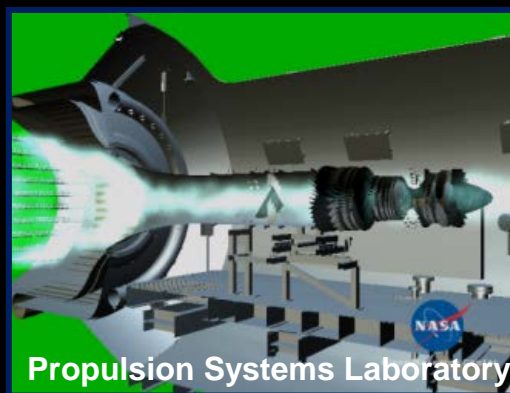
Engine Acoustic Research Facility

- Fan/nozzle acoustics research
- Simulate hot engine nozzles in flight
- Aerodynamic and Aeroacoustic measurements capabilities



Largest Icing Tunnel in US

- Aircraft icing certification
- Ice protection systems development
- Icing prediction/code validation



NASA's only altitude full-scale engine facility

- Jet Engine Icing Research
- Engine operability/performance
- Nozzle-engine integration/development



Over 50 Versatile Engine Component Facilities

- Combustor and Heat Transfer
- Compressor and Turbine
- Inlets and Nozzles



So, Who Is NASA Glenn today?



